

**METHOD FOR REMOVING AT LEAST ONE PARTIAL AREA OF A  
COMPONENT MADE OF METAL OR A METAL COMPOUND**

**CROSS REFERENCE TO RELATED APPLICATION**

[0001] This application is the US National Stage of International Application No. PCT/EP03/05573, filed May 27, 2003 and claims the benefit thereof. The International Application claims the benefits of European application No. 02011965.7 EP filed May 29, 2002, both of the applications are incorporated by reference herein in their entirety.

**FIELD OF THE INVENTION**

[0002] The invention relates to a method for removing a partial area, in particular a layer area, of a component consisting of metal or a metal compound, so that the partial area can be removed more easily after the method has been applied.

**BACKGROUND OF THE INVENTION**

[0003] In modern energy generation plants, such as for example gas turbine installations, efficiency plays an important role, since it is a parameter which can be used to reduce the costs of operation of the gas turbine installation. One possible way of increasing the efficiency and thereby reducing the operating costs is to increase inlet temperatures of a combustion gas within a gas turbine.

[0004] For this reason, ceramic thermal barrier coatings have been developed and are applied to components that are subject to thermal loading, for example made from superalloys, which are no longer able to withstand even the high inlet temperatures over the course of time.

[0005] The ceramic thermal barrier coating offers the advantage of a high thermal stability on account of its ceramic properties, and the metallic substrate offers the advantage of good mechanical properties in this assembly or layer system.

[0006] A bonding layer of composition MCrAlY (main constituents), in which M means that a metal comprising nickel, chromium or iron is used, is typically applied between the substrate and the ceramic thermal barrier coating.

[0007] The composition of these MCrAlY layers may vary, but despite the ceramic layer on top of them, all MCrAlY layers are subject to corrosion or degradation as a result of oxidation, sulfiding, nitriding, diffusion or other chemical and/or mechanical attacks.

[0008] It is often the case that the MCrAlY layer is degraded to a greater extent than the metallic substrate, i.e. the service life of the composite system comprising substrate and layer is determined by the service life of the MCrAlY layer.

[0009] After prolonged use, the MCrAlY interlayer only has a limited ability to function, whereas the substrate may still be fully functional.

[0010] Therefore, there is a need for the components which have been degraded in use, for example turbine blades, guide vanes or combustion chamber parts, to be reworked, during which process the corroded layers of the zones of the MCrAlY layer have to be removed in order if appropriate for new MCrAlY layers and/or then a thermal barrier coating to be applied. The use of existing, used substrates reduces the costs of operation of gas turbine installations.

[0011] In this context, it must be ensured that the design of the turbine blades is not altered, i.e. that there is a uniform removal of material from the surface.

[0012] Furthermore, there should be no residues of corrosion products, which represent a defect source during new coating with an MCrAlY layer and/or a ceramic thermal barrier coating and lead to poor bonding of the thermal barrier coating.

[0013] A method for removing corrosion products is known from US-A 6,217,668. In this method, the corroded component is accommodated in a large crucible, where the component is arranged in a powder bed with an aluminum source. The crucible must be partially closed and then heated in a furnace. The heating process supplies aluminum to the corroded component, with the result that the regions which had hitherto been more difficult to remove, i.e. which had a higher resistance to removal, can be removed by means of subsequent acid treatment. Large amounts of material are required for the powder bed, and the crucible takes up a large amount of space in the furnace during the heat treatment. The heating process also lasts longer, on account of the high heat capacity.

[0014] A further method for removing surface layers of metallic coatings is known from US-A 6,036,995. In this method, an aluminum source is applied to a corroded component in the form of a paste. However, the component together with the paste has to be heated until the aluminum melts, and consequently it is only then that aluminum can diffuse into the component. The molten aluminum layer is difficult to remove, since it bonds very well to the component.

#### SUMMARY OF THE INVENTION

[0015] The invention overcomes the described drawbacks by means of a method as described in the claims.

[0016] Further advantageous configurations of the method are listed in the subclaims.

[0017] The diffusion agent can be applied by simple, known coating methods, such as plasma spraying, evaporation coating, CVD, pack methods (component in a powder bed) or other methods (paste application).

### BRIEF DESCRIPTION OF THE DRAWINGS

[0018] The figures illustrate exemplary embodiments of the method according to the invention.

[0019] In the drawings:

[0020] figure 1 shows a corroded metallic component,

[0021] figure 2 shows a component to which the diffusion agent has been applied,

[0022] figure 3 shows the component illustrated in fig. 2 following a heat treatment,

[0023] figure 4 shows components which are being subjected to an acid treatment,

[0024] figures 5, 6 show components after an acid treatment for a method according to the invention and a method according to the prior art.

### DETAILED DESCRIPTION OF THE INVENTION

[0025] Figure 1 shows a component 1 made of metal, a metal alloy and/or a metal compound, which in at least one partial area at a surface 13 and/or in the interior of the component 1 has corrosion products 4 which are present, for example, in regions formed separated from one another. The corrosion products 4 may also be linked together or may be present on/underneath the entire surface 13, i.e. may also form a corrosion layer 4.

[0026] By way of example, the region enclosed by a dot-dashed line represents a partial area 28.

[0027] The component 1 may be a bulk component or a layer or a region of a composite or layer system 14. In the case of a layer system 14, there is a substrate 7 made from metal or ceramic, to which the metallic layer 10, for example an MCrAlY layer, has been applied; M indicates that a metal composed of nickel, chromium or iron is used.

[0028] The partial area 28 may also be a partial area of the layer 10 or may represent the entire layer 10 of the layer system 14 and/or part of the metallic substrate 7.

[0029] The corrosion products 4 have formed while the component 1 was in use and are undesirable for further use of the component and need to be removed. This is often done by a treatment in an acid bath.

[0030] However, it is also the case that the material of the component 1 beneath or above the layer 10 of degraded regions and/or the corrosion products 4 have a different reactivity in an acid bath, i.e. are more resistant to removal. The different solubility in the acid bath is caused by the different solubility of the corrosion products 4 or because an original composition of the material of the component 1 or the layer 10 has changed, e.g. because the corrosion product 4 removes a component from a region of the component 1 in the region around the corrosion product 4, where it produces a depletion region. This leads to nonuniform removal or even no removal of the corrosion products 4 or the material in the depletion region.

[0031] The method according to the invention makes it possible to remove the corrosion products or the altered layer or base material regions completely and uniformly with the material of the component 1 or the layer 10.

[0032] By way of example, in a first method step coarse removal of the corrosion products 4 or other regions can be effected by mechanical methods, such as for example sand blasting and/or chemical means, such as for example an acid bath.

[0033] In a further method step (fig. 2), a multi-component diffusion agent 16 is, for example, applied to the corroded component 1 on the surface 13, in particular in the region having the corrosion products 4, or to the corrosion

layer 4, or at least one component of the diffusion agent 16 diffuses into the component 1 directly from the gas phase, the corrosion products 4 in this example representing the regions which are more resistant to removal.

[0034] The diffusion agent 16 contains, for example, two components, both of which diffuse into the layer 10 or the component 1 as a result of a heat treatment, where they alter the chemical composition and materials. The diffusion and heat treatment can also give rise to the formation of new phases which can be removed more easily by an acid bath 19 (fig. 4).

[0035] Figure 3 shows a component as shown in figure 2, in which the diffusion agent 16 has completely diffused into the layer 10 as a result of a heat treatment at a temperature T. The layer 10 represents the partial area 28 that is to be removed, comprising not just regions that are more resistant to removal. The diffusion agent 16 is made up of at least two components. At least one component of the diffusion agent 16 is, for example, metallic, such as for example aluminum. By way of example, cobalt represents a further metallic component. Other components may include silicon or carbon.

[0036] The method functions particularly well if cobalt and aluminum diffuse into the partial area 28 as components of the diffusion agent 16.

[0037] In the example of an MCrAlY protective layer ( $M = \text{Fe, Ni, Co}$ ), the  $\gamma'$  phase is prevented from re-forming.

[0038] On the other hand, enriching the MCrAlY layer with aluminum and/or cobalt causes  $\gamma$  and  $\gamma'$  phase to be converted into an aluminum-rich  $\beta$  phase.

[0039] The enrichment with the elements or the phase transformation described allows improved acid attack.

[0040] Figure 4 shows two components which are arranged in an acid bath 19

or are exposed to an acid attack.

[0041] The component 1 or the layer system 14 and a component 22 according to the prior art, on which the method according to the invention has not been carried out, have corrosion products 4 and are exposed to the acid attack for the same time.

[0042] Figure 5 shows the component 22 following the acid treatment. The component 22 still has acid-resistant regions 25 which have not been removed or have been removed to a lesser extent during the acid attack, resulting in nonuniform removal of a layer area of the component 22.

[0043] By contrast, Figure 6 shows a component 1 or layer system 14 in which a layer area of the component 1 or the layer 10 has been removed uniformly.

[0044] The diffusion of the diffusion agent 16 has also enabled the partial area 28 to become so brittle that the partial area 28 can be removed by a mechanical treatment (sand blasting, ultrasound, dry ice blasting).